IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In Re Application of:	Darin Trees	)		
For:	Therapeutic Exercise Device	)	Conf. No.	6098
Serial No.:	10/695,117	)	Art Unit:	3764
Filed:	October 28, 2003	)	Examiner:	Lori Baker Amerson

DECLARATION UNDER 37 C.F.R. §1.31

I, Darin Trees, being over 18 years of age, a citizen of the United States and the State of Texas, hereby declare that:

1. I am the sole inventor of the subject matter described and claimed in the patent application identified above.

2. I invented the subject matter of claims 2 and 12 of the application identified above prior to October 13, 2003, as evidenced by my provisional patent application number 60/422,016, a copy of which is attached hereto, which was filed on October 29, 2002. The subject matter of claims 2 and 12 is described on page 13 of the provisional patent application, among other places, and illustrated in the drawings of said application.

3. I acknowledge that willful false statements and the like made herein are punishable by fine or imprisonment, or both under 18 U.S.C. §1001, and that such statements may jeopardize the validity of the application identified above or any patent issuing thereon.

4. All statements made herein of my own knowledge are true and all statements made on information and belief are believed to be true.

Darin Trees   5/2/07

Darin Trees   Date

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INVENTOR(S)

Given Name (first and middle [if any])	Family Name or Surname	Residence (City and either State or Foreign Country)
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☐ *Additional inventors are being named on the ____ separately numbered sheets attached hereto*

TITLE OF THE INVENTION (500 characters max)

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ENCLOSED APPLICATION PARTS *(check all that apply)*

☒ Specification *Number of Pages* 27
☐ Drawing(s) *Number of Sheets*
☐ Application Data Sheet. See 37 CFR 1.76
☐ CD(s), Number
☐ Other (specify)

METHOD OF PAYMENT OF FILING FEES FOR THIS PROVISIONAL APPLICATION FOR PATENT

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Respectfully submitted,

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Date 10/29/02

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USE ONLY FOR FILING A PROVISIONAL APPLICATION FOR PATENT

Use of a Modified Tilt Table for Preambulation Strength Training as an Adjunct to Burn Rehabilitation: A Case Series

Due to the system-wide complications that arise with prolonged bed rest, early mobilization plays a critical role in the recovery process, especially in the patient with significant burn injury. Unfortunately, early mobilization of patients with severe burns can be a difficult and uncontrolled task and often requires several people to lift a patient to a standing position. This article describes the use of a modified tilt table that allows patients to perform a weight-bearing exercise, such as an inclined squat, in a gravity-reduced environment. Use of the modified tilt table may offer a more suitable therapeutic option when treating critically ill patients by providing a safe and controlled transition from bed rest to ambulation. Perhaps most importantly, the table appears to provide psychological benefits by empowering the patient to take more of an active role during the early stage of recovery.

As the survival rate for patients with burns and severe injury steadily increases[1], so does the period of immobilization that is required to obtain medical stability. Lasting anywhere from a few days to several weeks, the accompanying detrimental effects of prolonged immobility, namely severe deconditioning, can create unique challenges for rehabilitation specialists.

Ambulation is traditionally one of the earliest functional tasks in burn rehabilitation. Although the benefits of early ambulation are well-established[2-5], the level of difficulty in mobilizing a previously bedridden patient with major burns is often underestimated. Factors such as severe weakness, impaired motor control, decreased cognitive status, pain, risk of graft shearing, and psychological factors (such as anxiety or fear of falling) can make mobilization a daunting task. As a result of these factors, critically ill patients with burns often require maximal assistance to stand upright and are unable to support their full body weight in order to take a single step. Essentially, therapists must lift the patient to a standing position while he or she attempts to bear weight through the legs. This event may lead to additional problems such as pain inflicted by therapists supporting burned areas and a decrease in the patients' self-confidence as they are not able to perform the normally routine task of standing without physical assistance.

An explanation for the patients' inability to support full body weight in standing is best expressed by several bed rest studies that have consistently shown that the first muscles to become weak during prolonged inactivity are those of the lower extremities that normally resist gravity; particularly the quadriceps and gastrocnemius-soleus muscle groups.[6-8] The antigravity muscles of the lower extremity (LE) are also reported to experience a greater loss of muscular torque with inactivity compared to non-antigravity muscles, declining by as much as 5% per day.[9,10,11]

An alternative to standing with full body weight is placing the patient on a tilt table and gradually tilting the patient to an upright position.[2,4] This technique not only allows for gradual weight-bearing through the LEs, but is also an effective treatment for orthostatic hypotension as a gradual retraining of the cardiovascular system to the upright position.[12] However effective, tilt table standing has its limitations as it is a passive event. The patient's muscles are involved in postural support only because the straps on the table restrict any movement. Although the tilt table helps to decrease orthostatic hypotension, it does little to improve LE strength or mobility. Further, weight-bearing duration on a tilt table may be limited by LE discomfort. This dependent pain is caused by the lack of a muscle-pumping action and resulting venous stasis.

As a result of concerns with the traditional method of early mobilization in the burn unit, the tilt table was modified in order to combine the benefits of upright standing with active exercise. The modification allowed patients to perform a weight-bearing exercise, such as an inclined squat, in a gravity-reduced environment. A surface with a railing system was fabricated and attached to a traditional tilt table base. A patient-supporting carriage with four low-friction bearing wheels was placed on the rails to allow the carriage to roll smoothly up and down on the rails. A series of holes in the rails were made for a pin to be inserted, limiting

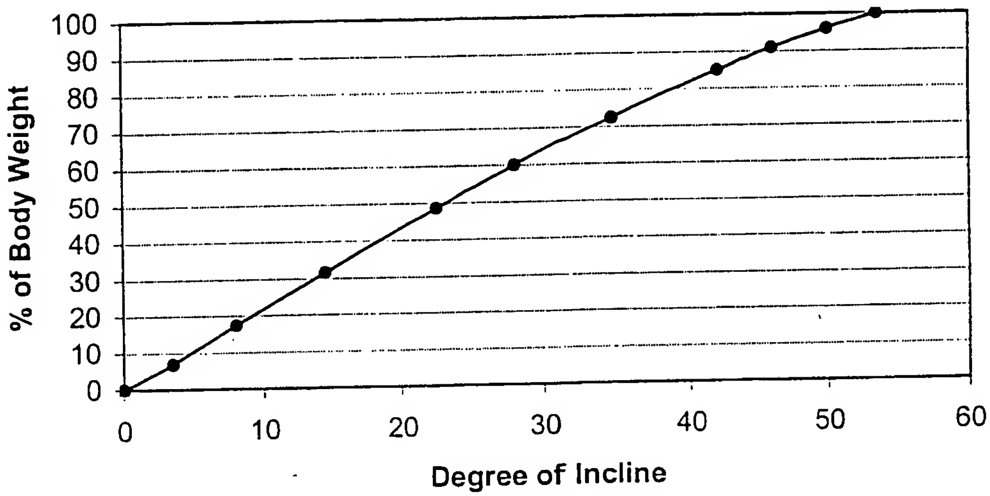

Table 1. Percentage of weight-bearing achieved at various angles on the modified tilt table.

the amount of carriage travel. At the distal end the platform was extended and a pad was applied to support the patient's legs. In addition, removable dip bars on the railing system were fabricated to allow a patient to perform upper extremity exercise.

The modified tilt table (MTT) was used in the following manner: The table was placed next to the patient's bed and the patient was laterally transferred with a draw sheet to the carriage with the legs positioned on the support pad. Once on the carriage a safety strap was applied around the patient's waist and the head of the carriage was elevated for enhanced respiration. With the carriage unlocked, the table was gradually tilted to an angle at which the patient was able to perform a controlled squat with a tolerable amount of resistance. The inclined squat exercise is defined as slowly flexing the knees to 80-degrees and returning to a position of full knee extension. If the patient was unable to obtain 80-degrees of flexion due to joint stiffness, the patient was asked to squat to the limit of maximum achievable knee flexion with a 5-second sustained stretch before pushing back into extension. The depth of the squat was determined by the position of the stopping pin, which was gradually lowered as the patient gained knee flexion.

The amount of force that the patient exerted to fully extend his or her knees from the squat position was dependent on the incline of the table (i.e., at 10-degrees, the patient lifted approximately 20% of body weight; at 30-degrees, he/she lifted approximately 65% of body weight) **(Table 1)**. These calculations were determined by placing a calibrated spring scale under the patient's feet on the platform as recommended by Sheldon[13]. By providing a constant coefficient of friction with the bearing wheels, the percentage of body weight could be predicted as the incline of the table and the patient's weight are the only variables. This reduced friction between the patient and the table surface would also minimize the risk of graft shearing on the patient's back since the carriage rolled with the patient.

As the patient developed more LE strength, the incline of the table was increased, thereby resulting in increased resistance and amount of weight-bearing. Once the patient could perform the exercise with a substantial portion of their body weight, such as 70% or a 35-degree angle, standing from a high surface could be initiated with less physical assistance as the patient had progressively strengthened the muscles responsible for the task of standing.

Theoretically this type of weight-bearing exercise, also known as closed-chain exercise, is ideal at the early stage of recovery because it mimics the functional use of a patient's legs during sit-to-stand. A closed-chain exercise facilitates co-contractions of several muscles (both prime movers and stabilizers), elicits eccentric muscle contractions, and promotes proprioceptive training with the joint compression.[14,15] Additional benefits of the inclined squat when working with patients with burns is that it encourages LE multi-joint ROM with the assistance of the patient's own body weight, isolates the antigravity muscle groups,

and may minimize bone loss associated with bed rest.[16]

This article describes four case reports in which the MTT was used for early mobilization and preambulation strength training.

Case 1

A 39-year-old-male was admitted to the burn unit with 71% TBSA burns and inhalation injury from a pipeline explosion. Prior to the accident, the patient was healthy, active and played soccer in a local league. Upon admission, full-thickness burns were identified to the scalp, face, ears, bilateral upper extremities, bilateral axillae, anterior and posterior trunk and buttocks. The patient developed subsequent compartment syndrome in bilateral upper extremities requiring escharotomies within the first 72 hours of admission, in addition to being placed on ventilatory support.

The patient underwent a total of seven surgeries for excision, debridement and placement of skin grafts to all burned areas, with donor sites spanning the circumference of both legs. Due to the placement of multiple skin grafts, the patient was not able to participate in therapy for 3-5 days after each surgery per the hospital protocol. As a result of the patient's pulmonary condition and the need for multiple surgeries the patient was essentially on bed rest for approximately 3 weeks following initial injury with only a few intermittent days of allowed activity.

At the time of initial evaluation, 13 days post-injury, the patient displayed bilateral plantar flexion contractures10-degrees from neutral and grossly poor LE strength. Functional mobility training was initiated on the same day of the evaluation. The patient required maximal assistance of three people for bed mobility and transfers secondary to generalized weakness and the location of the graft sites. The patient was placed on the MTT on the second day of physical therapy intervention and was able to perform 2 sets of 10 squats at a 15-degree angle with occasional assistance for knee ROM. In the subsequent treatment sessions, the patient was able to tolerate an incline of 20-degrees and perform 3 sets of 15 repetitions independently (**Figure 1**). As a result of the multiple surgeries and immobilization periods, the MTT was used as the primary means of progressing the patient through physical therapy over the following four weeks by gradually increasing the percentage of supported body weight and number of repetitions.

Once the patient could complete approximately 60 repetitions of squats on the table at a 35-degree angle, 57 days post-injury, transfer training was once again attempted. At this time the patient required maximal assist of two individuals to stand up and take 5 steps. The

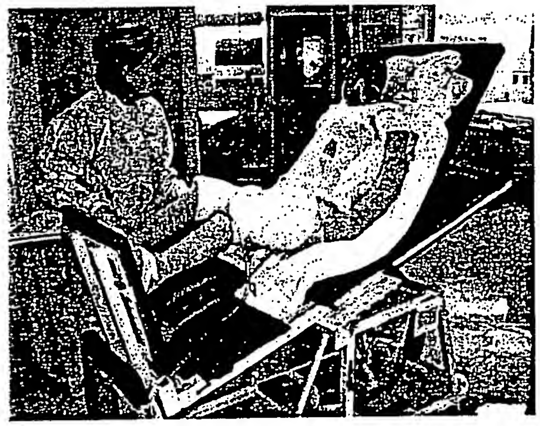

Figure 1. The patient was able to perform the inclined squat independently when unloaded to 40% of his body weight.

MTT was then used in conjunction with functional mobility and gait training for the next week until the patient had developed the strength to support his own body weight. The MTT was discontinued at that time to work exclusively on functional mobility and gait training. Prior to discharge to an inpatient rehabilitation unit, 66 days post-injury, the patient could dorsiflex his ankles to neutral, required minimum assistance for sit-to-stand, and was able to ambulate 90 feet with hand-held assistance of one individual.

Case 2

A 51-year-old male was admitted to the burn unit with 28% TBSA burns to the arms, chest and back after falling on a space heater. Past medical history revealed left hemiparesis from a stroke and peripheral vascular disease. Functionally, he had been an independent community ambulator with a cane. The patient was intubated for 24 days due to respiratory failure and underwent multiple surgeries for grafting and a left above-knee amputation (AKA). He was deemed stable for mobilization 25 days after admission.

Upon evaluation the patient had been weaned to a tracheal collar and followed commands appropriately. His right LE strength was grossly poor and his right knee ROM was 0-40-degrees, limited by pain from the donor site at the thigh. The patient was dependent for all bed mobility skills and required maximal assistance of three people to sit at the edge of the bed. He was only able to tolerate sitting for 15 seconds due to orthostatic hypotension.

The MTT was implemented the following day to strengthen the right leg and reduce orthostatic hypotension. During the initial treatment the patient was able to perform 3 sets

of 10 squats and heel lifts at a 20-degree angle and was able to increase his right knee flexion from 40 to 70-degrees by the end of the treatment **(Figure 2)**. The patient continued this exercise regimen for the next four days, increasing repetitions and degree of incline as the right LE strength progressed.

The patient then required skin grafting to the chest and therapy was placed on hold for the next 2 days. On the third post-grafting day and post-injury day 32, the MTT exercise was reinitiated as the patient continued with the unloaded squats and heel lifts at a 20-degree incline. The patient's ability to perform a stand pivot transfer from the bed to the chair was assessed on post-grafting day five. He required maximal assistance from 2 individuals because his right LE could not support his body weight. Unloaded squats were continued daily along with sitting balance activities during the afternoon treatment session to improve trunk control. By post-grafting day seven he was performing 3 sets of 15 squats at a 30-degree incline and displayed right knee flexion to 90-degrees. The patient was able to support his own body weight with the right LE during upright standing and performed a stand-pivot transfer to the wheelchair with moderate assistance for balance. He was discharged to inpatient rehabilitation 48 days post-injury to continue functional mobility training.

Case 3

A 15-year-old male was admitted to the burn unit with a traumatic brain injury (TBI), multiple vertebral fractures, and 30% TBSA burns after a car accident. Prior to the accident he was an active student and played football. After multiple surgeries for skin grafting and 45 days of bed rest, the patient was medically cleared for mobilization.

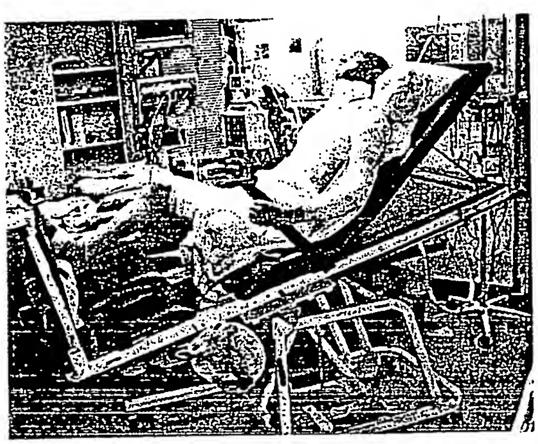

Figure 2. Patient performing unilateral LE extensor strengthening using his body weight for resistance.

During the evaluation the patient was in a cervical collar and demonstrated an impaired cognitive status by only responding to simple commands. LE strength was grossly poor and there were no LE joint limitations. On the initial attempt to stand the patient was unable to support his own body weight, required maximal assistance of 3 people, and had difficulty comprehending the complex task of upright standing. The MTT was initiated on the second day of therapy in order to provide a controlled environment for weight-bearing exercise. The patient was able to actively perform 3 sets of 10 squats at a 20-degree angle independently **(Figure 3)**.

The following morning 4 sets of 15 squats were performed at a 30-degree angle on the MTT and mobility status was re-assessed during the evening therapy session. At that time he required moderate assistance of two people (hand-held on both sides) to stand and was able to ambulate 40 feet. The MTT was then discontinued as the patient's balance and coordination became priority concerns. Functional mobility training was continued twice a day and by discharge to inpatient rehabilitation, 66 days post-injury, he was walking 250-feet with minimal assistance (hand-held) for balance.

Case 4

A 16-year-old female was transferred to our burn unit from an outside hospital 9 days after a severe car accident. She suffered a TBI, full-thickness burns to the legs, a right femur fracture, and a left acetabular fracture. The patient underwent a right femur open reduction and internal fixation (ORIF) prior to her transfer and received skin grafting once admitted to our

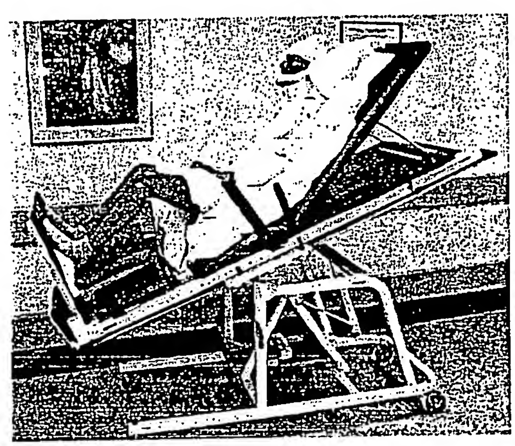

Figure 3. The controlled environment allowed the patient to safely begin lower extremity weight bearing.

unit. In addition, all of her toes were non-viable and required amputation. She later underwent an acetabular ORIF and was placed on strict hip precautions (posterior hip precautions and no hip flexion greater than 30-degrees) due to the severity of the fracture. Weight-bearing status was 'as tolerated' on the right leg and non-weight-bearing (NWB) on the left leg. The patient was cleared for mobilization 22 days after the accident. She had been active and independent, playing volleyball and cheerleading, prior to her injury.

After a thorough evaluation, potential areas of limitation to functional mobility were identified. Limitations included right knee flexion to 40-degrees, an inability to tolerate excessive pressure through the right foot due to pain related to the burns and amputated toes, strict hip precautions, and decreased pain tolerance. Bed mobility and traditional transfer training was not possible secondary to the inability to flex the left hip past 30-degrees. Full standing was also limited due to the NWB status of the left lower extremity and inability of the right foot to support full body weight. With this in mind, it was apparent that the MTT exercise was the most appropriate treatment choice to begin gradual weight-bearing on the right leg.

In order to accommodate the patient's left NWB restriction, an additional pad was fabricated to support the patient's leg during the exercise. The pad was inserted into the inferior border of the carriage. In addition, the platform was shifted laterally in order to allow a unilateral squat without the NWB extremity coming in contact with the platform.

Exercise on the MTT began the day after the evaluation and she started with unloaded squats at a 20-degree incline. Dip bars were utilized for upper extremity strengthening as well as to assist in right knee flexion stretching. The patient pulled on the dip bars during eccentric flexion to increase knee ROM and pushed with her arms during concentric extension to strengthen her triceps and shoulder depressor muscles **(Figure 4)**. During the initial treatment session the patient completed 5 sets of 10 repetitions at a 20-degree incline and her right knee ROM increased from 40 to 65-degrees of flexion.

The MTT was used daily in conjunction with functional mobility training. The patient initially required maximal assist of three individuals to stand with a platform walker for ten seconds due to pain and wound bleeding. After ten days, the patient achieved 0-80 degrees right knee ROM, required moderate assistance of one to stand, and moderate assistance of two individuals to ambulate with a rolling walker 12 feet **(Figure 5)**. (The patient required assistance to maintain NWB of left LE.) The MTT was discontinued at this time and the patient was discharged to pediatric rehabilitation post-injury day 32.

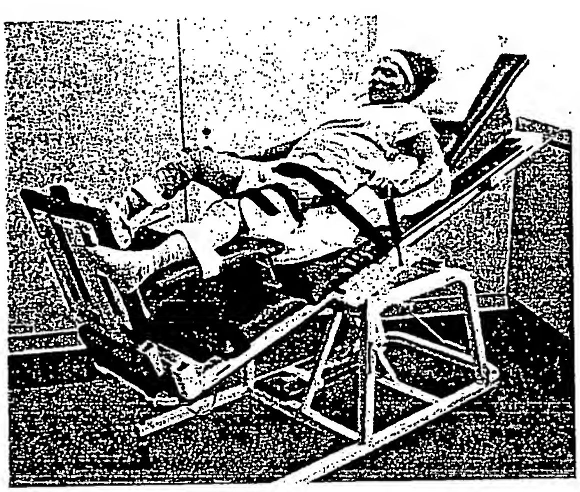

Figure 4. The NWB pad accommodated for the NWB restriction, allowing graded weight bearing on the right LE and upper extremity strengthening with the dip bars.

Discussion

The concept of utilizing a tilt table for progressive resistance exercise was first reported in 1979. In the article, Thomas and colleagues described an improvised roller system, using 2 sheets of plywood and barbell bars, which allowed an individual to perform an inclined squat on the table's surface.[17] Unfortunately, there

Figure 5. Patient tolerates full body weight on the right leg and is able to walk twelve feet with a walker.

were no documented clinical cases in which the technique was applied with patients. In fact, no mention of the technique was found in the literature after the 1979 publication.

In the four cases described, the MTT was implemented in the plan of care for various, though similar, indications. In case one, a patient with extensive burns and severe deconditioning, the table was used primarily for closed-chain strengthening until he was able to support his own body weight in standing. In case two, a patient with burns and a left AKA, the table was used to increase strength in the unaffected leg that required a significant amount of strength to perform a stand-pivot transfer to a wheelchair. In case three, a patient with burns and an impaired cognitive status, the MTT was used to provide a controlled environment in which the patient could participate in a weight-bearing exercise. Finally in case four, a patient with LE burns, TBI, and a NWB restriction, the table was used as a desensitization technique to begin graded weight-bearing on a foot with severe burns and amputated toes.

The integration of unloaded closed-chain exercise on the MTT appeared advantageous in the preambulation treatment routine of these patients. First, the table allowed patients the freedom of movement by lessening the effects of gravity and reducing body weight. In fact, patients often times demonstrated greater knee flexion during the terminal stretch portion of the squat than they displayed during active-assisted ROM in supine or sitting. The increase in motion may have been due to the decreased apprehension and muscle guarding when the patients were able to independently control the amount of flexion while supported by mechanical means.

Second, the MTT allowed the patients to progressively strengthen their lower extremities at levels they could tolerate. By unloading a portion of body weight, the patients were able to participate in selective training of those muscle groups most seriously affected by prolonged bed rest using a gradual, progressive resistance program. The patients also endured longer periods of weight-bearing on the table during initial mobilization compared to standing upright with assistance. The muscle pumping action of the LEs during the weight-bearing exercise sessions likely contributed to venous return, allowing the longer standing periods.

The MTT was particularly useful if the patient was lethargic and could not comprehend the complex task of standing after several days of bedrest. Although the workout sessions were more effective when the patient was fully alert, the patient did not need to be completely oriented to safely exercise on the table. Standing the disoriented patient at bedside however often requires several assistants and there is still a risk of falling. In addition, a therapist may hesitate to stand a patient with an altered mental status, thus further prolonging the patient's time in bed and increasing the risk of bed rest complications.

Additional benefits of using the MTT in these four cases may be related to the psychosocial aspect of rehabilitation. By adjusting the incline of the table, the therapist was able to reduce the effects of gravity to an exercise intensity the patient could achieve independently. Patients reported feeling a greater sense of motivation and accomplishment when able to perform the activity without physical assistance. The MTT also allowed the patients to be active participants in the therapy sessions. Patients verbalized their readiness to increase the angle of the table, lower the stopping pin to allow greater knee flexion, or perform more repetitions at a specified incline.

Finally, the measures of incline (and thus percentage of body weight being lifted), depth of squat (increasing knee flexion), and number of repetitions allowed both the patient and the therapists to observe objective progress. Small improvements in LE extensor strength might not be discerned with the traditional method of lifting the patients or with manual muscle testing. When the patient was unloaded to a percentage of his or her own body weight however, subtle changes in muscle strength could be detected. For example, a patient could perform the inclined squat at a small increase in the incline or with more repetitions at the same incline compared to the previous day's exercise session. The use of the apparatus appeared to improve the patients' self-esteem, compliance with therapy, and motivate them toward a goal of independent standing.

It is also important to point out that we used the MTT as an adjunct to burn rehabilitation techniques. Although the closed-chain exercise on the table simulated a functional activity, it did not replace traditional functional mobility training. Once a patient had developed the necessary strength to stand and take steps, the table was discontinued to focus attention on the other components of standing such as balance, coordination, and standing tolerance. Initial standing still required assistance; however, the strengthening and ROM components were dealt with in a way that appeared to be patient-friendly and gave the patient a sense of accomplishment.

Summary

The initial mobilization of patients with burns and severe deconditioning from prolonged immobility presents a unique challenge for rehabilitation specialists. In the past, physical manpower has been used to initiate the early mobilization to a standing position. This approach has proven to be quite taxing and

psychologically degrading for the patient who is unable to support his or her own body weight in standing. Unloaded closed-chain exercise may be a missing link in the rehabilitation progression from bed rest to ambulation. This technique enables a patient to make the transition to standing in an efficient and safe manner.

Further research is needed to examine the effects of preambulation strength training on a MTT when treating critically ill patients. Such studies should focus on increasing motion in limited joints, reducing bed rest complications, expediting functional mobility, and improving self-efficacy related to ambulation. Although initially developed for patients with burns, the technique may offer a suitable therapeutic option for a variety of patient populations who are unable to support their full body weight and require a graded transition to ambulation.

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<u>*Rehabilitation Table and Method of Use*</u>

Inventor- Darin Trees

Background of the Invention

1. Field

The subject invention is in the field of rehabilitation equipment for patients with severe muscle weakness and the inability to stand with full body weight. Medical advances are allowing more patients to survive serious injuries or disease processes. Unfortunately, the period of immobility required to obtain medical stability leads to severe deterioration of muscle strength and the patients' inability to support their own body weight in standing. A current challenge for rehabilitation specialists is helping these patients regain the ability to walk, especially patients with obesity. One option is to summon as many colleagues as possible and lift the patient to a standing position while they attempt to bear weight through the lower extremities. Unfortunately, this technique is not only physically taxing on therapists but it is psychologically degrading for the patient as the activity is too difficult and reinforces the patient's dependence on others.

An alternative to mobilizing deconditioned patients with manpower is to use a tilt table. The tilt table resembles a stretcher and the top portion can be tilted gradually from a horizontal to a vertical position. A platform at the lower or distal end prevents the patient from sliding down and allows weight-bearing through the patients' legs. The patient is transferred laterally using a draw sheet from their bed to the tilt table surface and secured to the tabletop with straps placed across the knees and waist. The table's surface is then tilted to the desired inclination. The benefits of tilt table standing include a gradual retraining of the cardiovascular system to the upright position and the ability to begin gradual weight-bearing on the lower extremities.

Unfortunately, tilt tables have a significant limitation. The tilt table is only able to bring the patient to an upright position while simultaneously restricting movement of the patient's lower extremities. This restriction prevents joint range-of-motion and greatly limits strengthening of the patient's lower extremity musculature, as the legs are strapped to the table. The current tilt table design has no mechanism to enable the patient to perform lower or upper extremity strengthening exercise while gradually increasing the weight born by the patient.

2. Prior Art

Exercise machines with a movable sled on inclined rails, which the user exercises against his or her own body weight, are well known in the art. For example, in US Patent No. 5,169,363, Campanaro describes a device with a torso-supporting carriage that slides on a pair of rails for lower extremity exercise. Similar devices are shown in US Patent No. 5,263,913, US Patent No. 4,383,684, and Patent No. 5,938,571. These pieces of stationary equipment were designed for healthy users that are able to stand and get on the apparatus to begin exercising. In fact, the user must get on and off the device in order to change the incline or resistance level of the exercise. Further, the devices are made for a population of users for simultaneous bilateral lower extremity exercise. None of the apparatuses are accessible to users that are unable to stand and/or users with one lower extremity that is non-weight

bearing, such as a fractured or amputated leg. It would be unsafe to use these devices on the population of patient's with severe weakness.

The closest prior art is described in Patent No. 5,885,197 where Barton discloses an exercise apparatus with a stationary support frame and a movable sled in which the user is able to perform a squatting exercise. There is a motor-driven means for changing said angle. Although users are able to remain on the apparatus while the incline is changed, it is not safe for patients with severe deconditioning. There is no means of locking the sled in place while a user mounts the machine and no means of adjusting the sled travel. If a patient's knees were to buckle, the sled would slide down the rails and injure the patient. In addition, a patient with severe weakness would be unable to keep their feet on the platform, as there is no means of supporting the legs or securing the feet to the platform. Barton's carriage also has shoulder rests to allow healthy users to push the carriage for resistance training. These shoulder rests would prevent a lateral transfer from a patient's bed. The only way to mount the device would be to sit on the carriage and slowly lower down between the rests. Figure 9 in Barton's patent also shows how the table's incline could be inverted to tilt backwards. While beneficial for healthy users to perform hamstring exercises, the application is unsafe for patients with deconditioning as it could cause serious injury if a patient slid backwards onto his or her head. Also, the sled is flat and made for healthy users. Patients with respiratory problems, such as those on ventilators or with obesity, would not be able to use the apparatus because they are unable to lay flat for extended periods. Barton also discloses hand grips located on the guide rails for upper extremity workouts on the table. The problem arises, however, that these grips only face upwards, preventing a lateral transfer onto the apparatus from a patient's bed. Barton also shows how the table could be inclined to a vertical position in Figure 7. Although this resembles the action of a tilt table, it cannot be used as a tilt table as there is no means to secure a patient's legs to the table. With the carriage unlocked and no means of securing the carriage to the rails, a patient with severe lower extremity weakness could be severely injured as they cannot support their own body weight, much less the added weight of the carriage. Finally, the device is stationary and only allows users to exercise with both legs simultaneously. There is no means of supporting one, or both, legs in order to accommodate patients with non-weight-bearing restrictions.

Traction tables, in which a force is applied to effect spinal distraction, are also well known in the art. The Morin Patent No. 3,741,200 describes a tilting table with multiple sections that can be released to produce spinal traction on a patient by the action of gravity. A similar device is disclosed in Patent No. 5,024,214. Inversion tables, which invert to produce spinal traction, are described in Patent No. 5,551,937, and Patent No. 4,867,143, and Patent No. 5,967,956. Motorized versions of the traction table are described in Patent No. 4,113,250 and Patent No. 4,672,697. These tables are similar in looks, but are designed to treat back and neck ailments by inverting backwards. The tables would not be used for the treatment of muscular weakness and would be unsafe to use on the population of patients with severe deconditioning. Tilting backwards could lead to respiratory distress, increased blood pressure and increased intracranial pressure for deconditioned patients, all of which are seriously harmful to the patients.

Summary of the Invention

The present invention is a mobile rehabilitation table developed for patients with severe weakness that incorporates the benefits of tilt table standing and weight-bearing strengthening exercise. A first objective of the invention is to be used as a traditional tilt table. The apparatus involves three sections- a carriage, a center section, and a lower extremity support pad. A split platform is located at the bottom of the table to allow weight-bearing through the legs. When all three sections are locked down to the guide rail system, the apparatus can be used as a traditional tilt table allowing inclination from 0-degrees, or horizontal, to 85-degrees. Safety straps are placed at the patient's knees and waist to secure the patient to the table. **(See Figure 1)** This allows for passive standing when a patient requires gradual weight bearing on the legs but is not able to actively use their legs. Examples include patients with complete spinal cord injuries or those with an altered mental status.

Another objective of the table is to convert from a tilt table to an exercise apparatus by adjusting the three sections of the table. A tilt table with the ability to convert into an exercise device will benefit medical facilities by eliminating the purchase of two devices and increasing storage space. The patient-supporting carriage with low-friction bearing wheels is mounted on a guide rail system to allow the carriage to smoothly roll up and down on the table. The carriage has safety straps to secure the patient to the carriage and a locking mechanism to secure the carriage in place with respect to the rails. A split platform is fixed to the distal end of the frame to allow weight bearing. The platforms also have foot straps to secure the feet onto the surface and prevent the leg from rotating laterally.

The method of use is as follows: The safety switch is first placed in the 'exercise' mode. To convert the table into an exercise device, the leg support pad is raised to allow the center section to slide underneath the support pad. Wheels on the base allow therapists to move the table next to a patient's bed and the height of the table allows a therapist to transfer a patient directly from their bed onto the surface of the apparatus while in a supine position. The patient is secured to the locked carriage with safety straps across their waist. The head of the carriage is raised to enhance respiration and the feet are secured to the platforms with foot straps. After the patient is secured, the carriage is unlocked and the table is gradually tilted to an incline at which the patient is able to perform a shallow, controlled squat by flexing his or her knees and extending back up to a 'standing' position. **(See Figure 2)**

The center section limits the amount of carriage travel or squat depth. When the center section is adjusted to a higher position on the rails, the carriage is limited to travel a short distance allowing the patient to perform a shallow squat exercise. When positioned lower on the table, it allows greater knee flexion or a deeper squat. This pad also serves as a safety mechanism by preventing the patient from sliding down the table if the knees were to buckle. When the patient requires a rest break, the therapist locks the carriage back in place and lowers the table's incline.

The amount of force the patient must exert to fully extend his or her knees from the squat position is dependent on the incline of the table. For example, a 20-degree tilt is approximately 40% of the patient's weight and a 30-degree tilt is approximately 60% of the patient's body weight. This ability to change resistance levels allows therapists to adjust the exercise intensity to a patient's tolerance while the patient remains on the table.

This type of weight-bearing exercise is ideal during the acute stage of recovery because it simulates the sit-to-stand activity while bearing only a portion of the patient's body weight in a very controlled and secure environment. It also facilitates strengthening of the leg extensors, which are vital in performing sit-to-stand. The tilt of the table can be gradually increased daily until the patient's leg strength is strong enough to perform the exercise with a substantial percentage of his or her body weight such as 70% or a 35-degree incline. When the table is in the 'exercise' mode, the tilting mechanism will only allow 0-35-degree inclination. Standing from a chair or bed can then be initiated safely with less assistance from the therapist, as the patient has progressively strengthened the muscles responsible for performing the task of standing.

Another objective of the table is to allow upper extremity exercise. Adjustable dip bars are located on either sides of the carriage to allow a patient to participate in upper extremity exercise while exercising their legs. These bars are also used to allow a patient to increase his or her knee flexion by pulling with their arms and gradually stretching the knee joint during the squat exercise. The bars can be adjusted by sliding up or down to accommodate the patient's height. Another important feature of the dip bars is that they can be rotated downwards. This allows therapists to transfer the patient laterally onto the table from their bed without coming into contact with the bars. The bars are rotated upwards when upper extremity exercise is desired.

Still another objective is to allow a patient to participate in one-leg strengthening exercise. The table can be used for patients with a weight-bearing restriction on one leg. Examples include when a patient has a lower extremity fracture or amputation. A non-weight-bearing (NWB) pad inserts into one of two eyelets located at the inferior border of the carriage, supporting the involved lower extremity. The platform is split and by removing the platform side of the involved leg, a patient is able to perform the lower extremity squatting exercise exclusively with the uninvolved leg without the leg coming in contact with the platform. **(See Figure 3)** The table is used daily until the patient is ready to progress to standing up from the bed with the assistance of a walker.

It is also used in neurological rehabilitation when a patient has one-sided weakness caused by a stroke or a closed head injury. In this application, the NWB pad supports the unaffected leg allowing the patient to focus on strengthening and motor control of the affected leg at a portion of their own body weight.

Finally, the last objective is to allow patients with bilateral leg involvement to participate in exclusive upper extremity workouts. Two NWB pads are inserted into both eyelets on the lower carriage to support both legs. In this application, both sides of the split platform are removed to allow the patient to slide down and push back up for shoulder depressor strengthening. **(See Figure 4)** This would be used for patients that are unable to use their legs such as those with bilateral lower extremity fractures, bilateral amputations, or patients with complete spinal cord injuries to strengthen their arm muscles. These patients will progress to scooting into a wheelchair using their upper extremity strength.

Description of the Drawings

1. Guide rails

Guide rails **(1)** extend the length of the table and have an opening towards the inside in which the low-friction bearing wheels track.

2. Split Platform

The platform **(2)** is split to allow one side to be removed when performing a one-legged squat with the non-weight-bearing pad. The platforms also have foot straps **(3)** to secure patients' feet on the platform and prevent the leg from rotating laterally.

3. Mobile Base with Tilting Mechanism and Storage Capacity

The base is on locking wheels **(4)** allowing it to be transported to patients' rooms and locked next to a patient's bed. The height of the table is important as it allows a patient to be transferred onto the table from their bed while in a supine position. The tilting mechanism allows the table's incline to increase from horizontal (0-degrees) to 85-degrees. The mechanism can be electrically motor-driven **(5)** or manually with a crank system (Not shown). A footswitch is connected to the electrical component to incline or decline the table surface. The base has the ability to store various items such as the non-weight-bearing pad, towels, and cleaning supplies. **(6)**

The base can also be made to elevate to different heights from 18 inches to 38 inches with an electric hi/lo mechanism. This feature would make the apparatus accessible from a wheelchair or accommodate transfers from different bed heights. (Not shown)

4. Patient-Supporting Carriage with Locking Mechanism and Ability to Elevate Head

The patient-supporting carriage **(7)** has a safety strap **(8)** to secure a patient onto the carriage and 4 low-friction bearing wheels **(9)** underneath that track in the guide rails **(1)**. Handles **(10)** located on the sides of the carriage are attached to a locking assembly **(11)**, also underneath the carriage. When turned on either side, the locking mechanism lowers down onto a bolt **(12)** located on the rail base to lock the carriage in respect to the rails. When unlocked, the carriage is free to glide up and down on the rails, allowing the patient to perform a squat exercise.

The head of the carriage has the ability to be raised either manually, with a kickstand-type mechanism **(13)**, or with a gas-powered spring (Not shown). This feature is important for patients with respiratory problems, as they are unable to lay flat for extended periods. A strap **(14)** located on the superior portion of the carriage prevents the head of the carriage from advancing forwards when the apparatus is used as a tilt table in the upright position.

5. Center Section with Locking Mechanism

The center section **(15)** of the table acts as a stopping mechanism when the table is used as an exercise device by sliding underneath the adjustable leg support pad. Similar to the locking mechanism on the carriage, it can be locked down to the rails at different levels depending on the desired amount of carriage travel with the turn of a lever **(16)** located on both sides. The locking mechanism lowers down onto a bolt **(17)** located on the railing system. The center section also has 4 wheels underneath to track in the guide rails **(1)**.

A knee strap **(19)** is located on the center section to secure patients' knees when the table is used as a tilt table.

6. Adjustable Leg Support Pad

The leg support **(20)** is located at the distal end of the table and has the ability to be raised or lowered by pulling up on a lever **(21)** located on either side of the pad. When the apparatus is used as a tilt table, it is in the lowered position to make the entire table surface flat. In order to transform the apparatus to an exercise device, the support pad is raised and the center section is lowered underneath the support pad. Patients with severe lower extremity weakness are unable to lift their legs and require the pad to support their feet on the platforms.

7. Adjustable Dip Bars

Dip bars **(22)** are located on both sides of the table and can be adjusted to the patients' height. These bars are used for strengthening the arm muscles when pushing down and also allow a patient to pull with their arms to increase knee flexion. Examples would include patients with burns or knee replacements. The dip bars can be rotated downward during a patient's lateral transfer from the bed to the table and upward when exercising.

8. Non-Weight Bearing (NWB) Pad

The NWB pad **(23)** allows a patient with a weight-bearing restriction to safely exercise on the table. Examples would include patients with an amputation or a leg fracture. The pad inserts into a slot **(24)** located on the inferior border of the carriage. A safety strap **(25)** secures the leg onto the pad. In addition, one side of the split platform is removed to allow the patient to perform a one-legged squat without the leg coming into contact with the platform.

9. Safety Switch

A safety switch **(26)** is located on the table's base to identify the table's use as a tilt table or an exercise device. When working with deconditioned patients, it is only necessary to exercise to a limit of 35-degrees or 70% body weight. Standing upright is the next rehabilitation progression. When the switch is turned to the 'EXERCISE' mode, the tilting mechanism will not exceed 35-degrees. If the tilt table application is desired, the switch is turned to the 'TILT TABLE' mode allowing 0-85-degrees inclination. This safety mechanism ensures a therapist from over-tilting the table during exercise with a patient.

Summary of Improvements:

1. The ability to be used as a traditional tilt table with all sections locked to the rails and the patient secured to the table at the knees and waist. The table can be inclined from 0-degrees (horizontal) to 85-degrees.

2. The ability to convert from a tilt table to an exercise device by allowing the center section to slide underneath the support pad and limit the carriage travel while the patient performs a controlled squat exercise.

3. The ability for the carriage's head to be elevated to enhance respiration.

4. The ability for a patient to perform a one-legged squat by using the non-weight bearing pad to support the affected extremity and one side of the platform to be removed. This allows the patient to perform a safe one-legged squat without the leg coming in contact with the platform. A safety strap on the pad secures the leg to the pad.

5. The ability to perform an exclusive upper extremity by using 2 non-weight bearing pads under both legs and removing both sides of the platform to allow an upper extremity dip for shoulder and elbow strengthening.

6. Footstraps on the split platform to secure the feet to the platform and prevent the leg from rotating laterally.

7. Dip bars that rotate downwards to allow a patient to be transferred onto the table from their bed while supine.

8. A base that is mobile and can store items such as the NWB pad and cleaning supplies. The incline can be increased either manually or with an electric tilting mechanism.

9. Safety switch to identify table's use as a tilt table (0-85-degrees) or exercise apparatus (0-35-degrees).

Figure 1. Side view of tilt table use

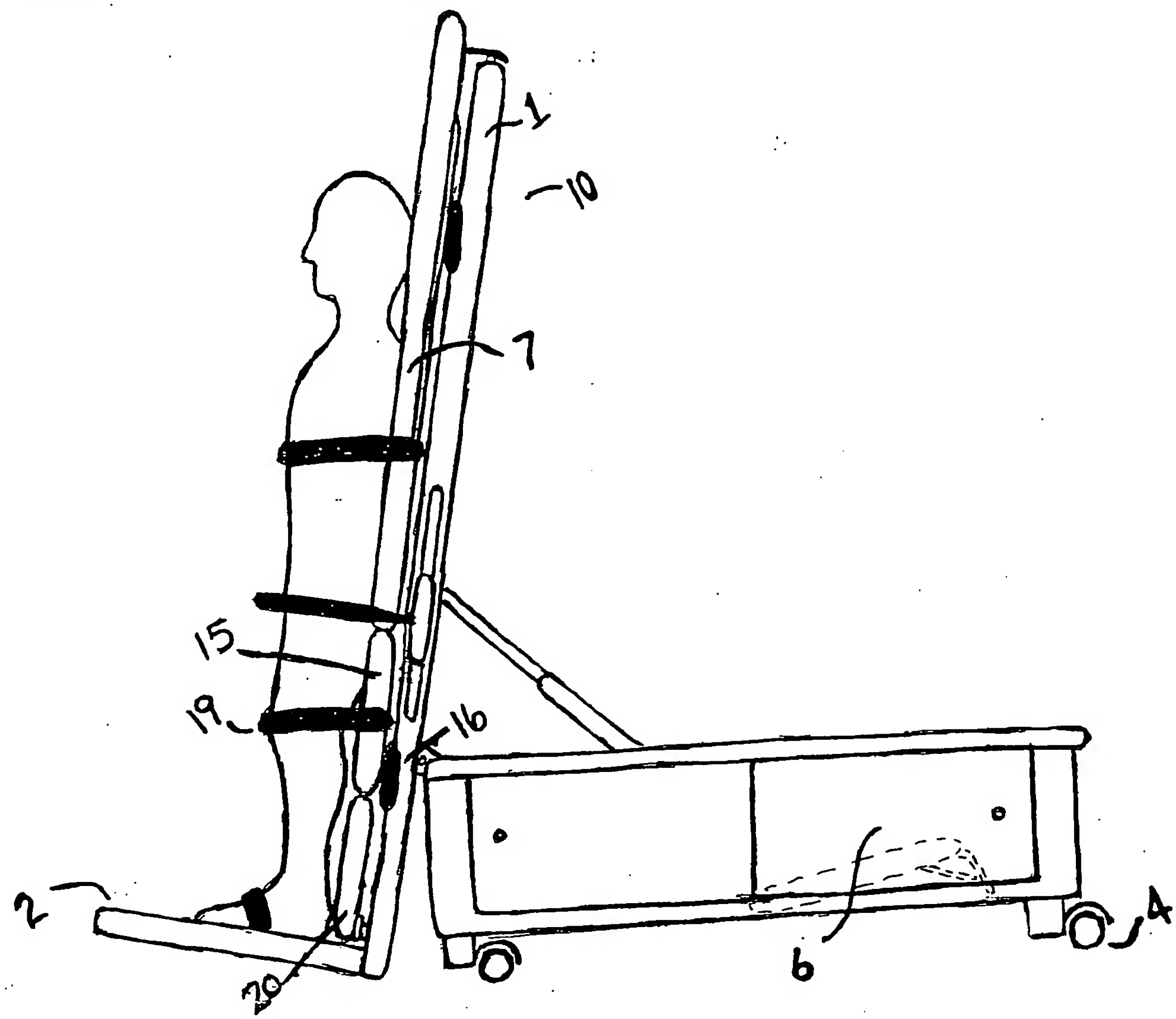


Figure 2. Side view of both leg exercise use

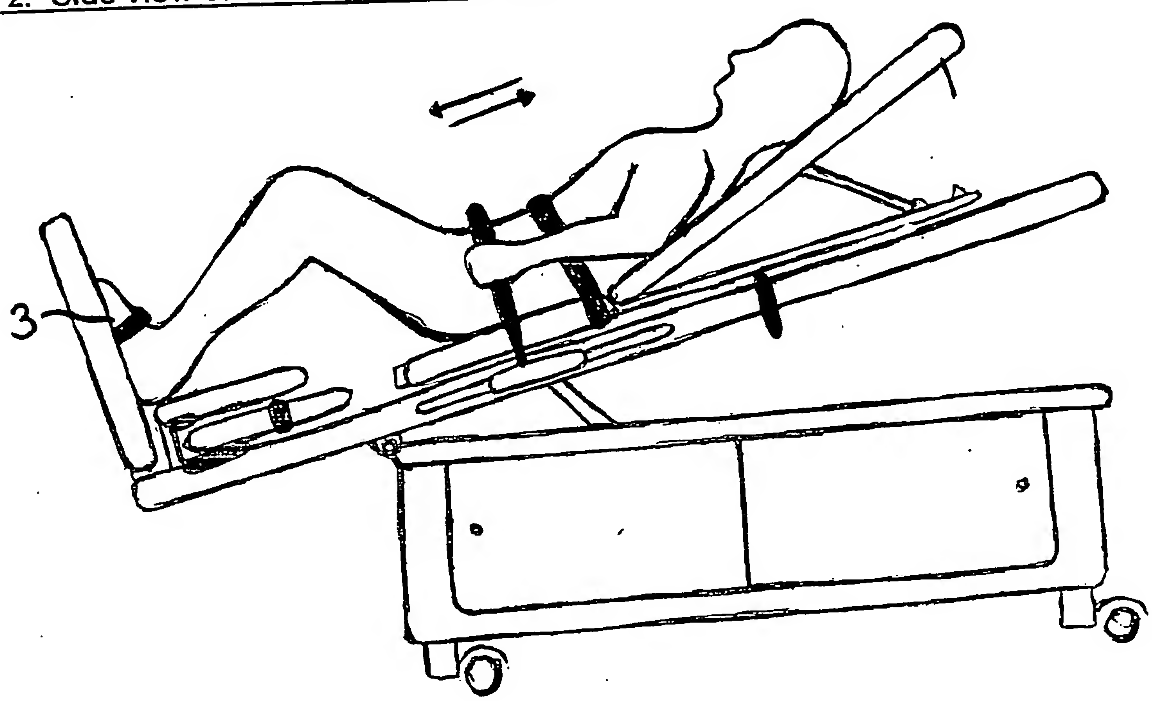


Figure 3. Side view of one leg exercise use

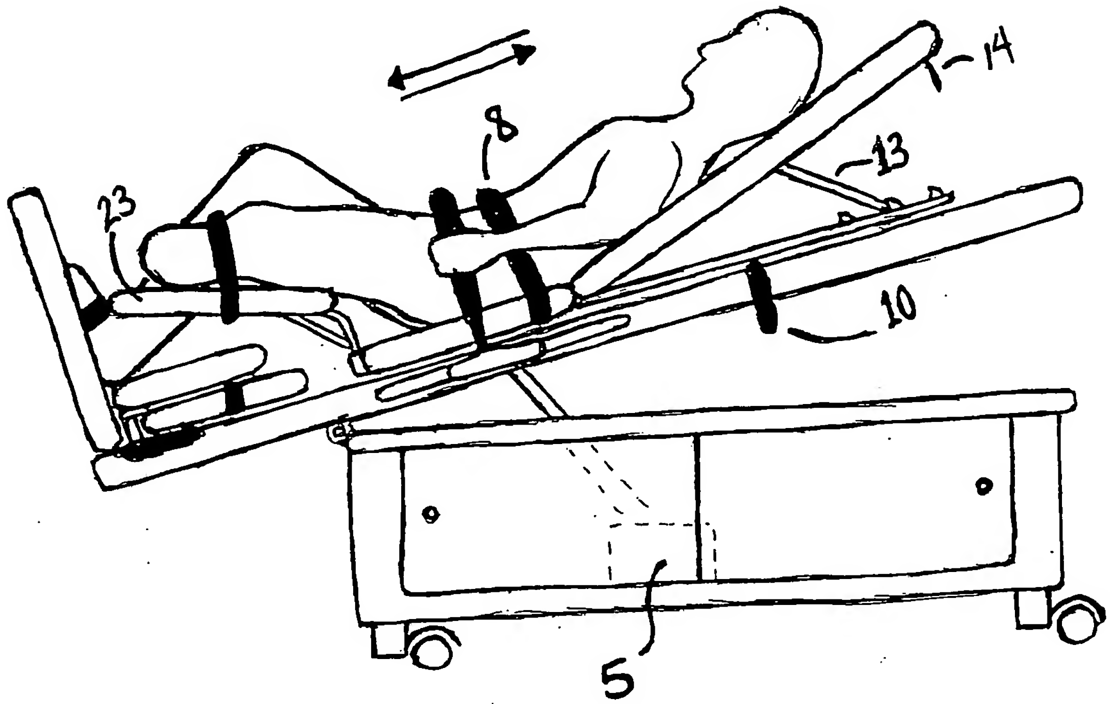
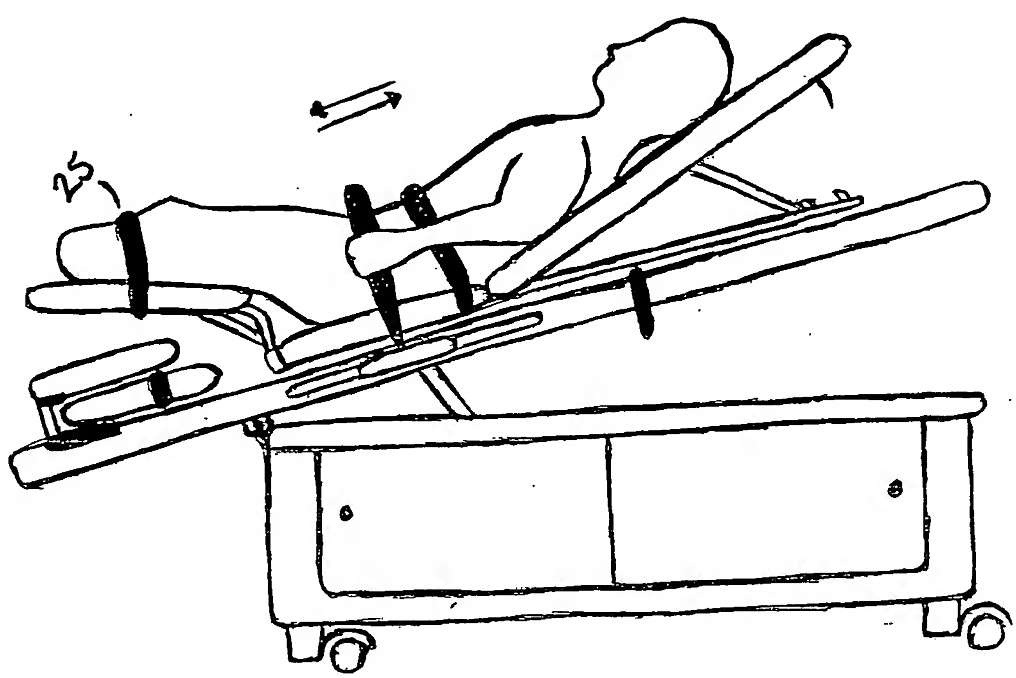
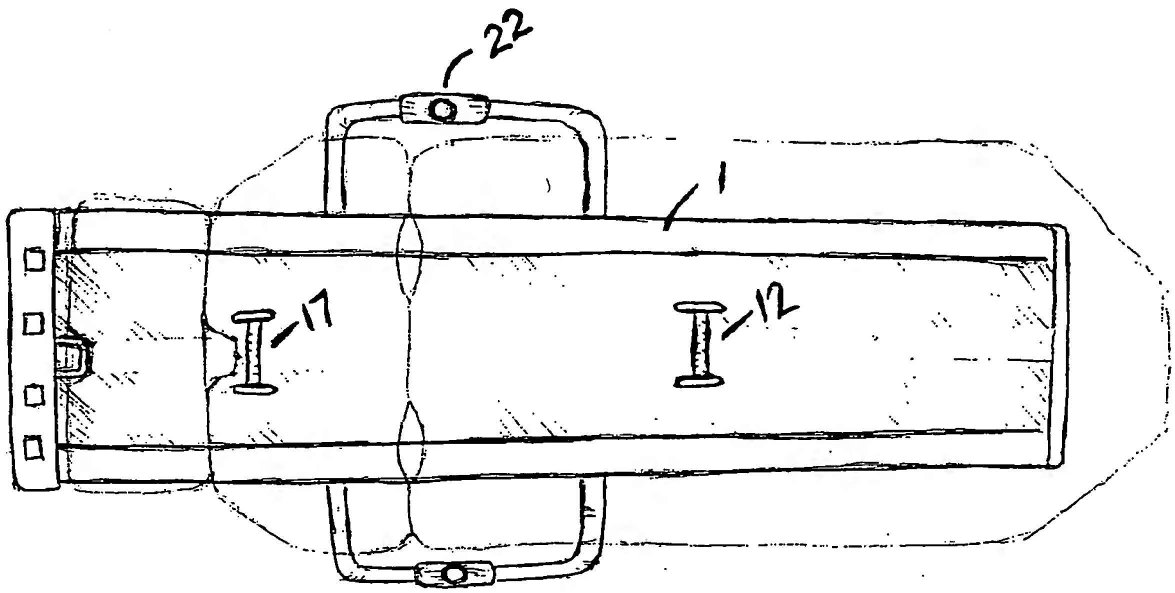


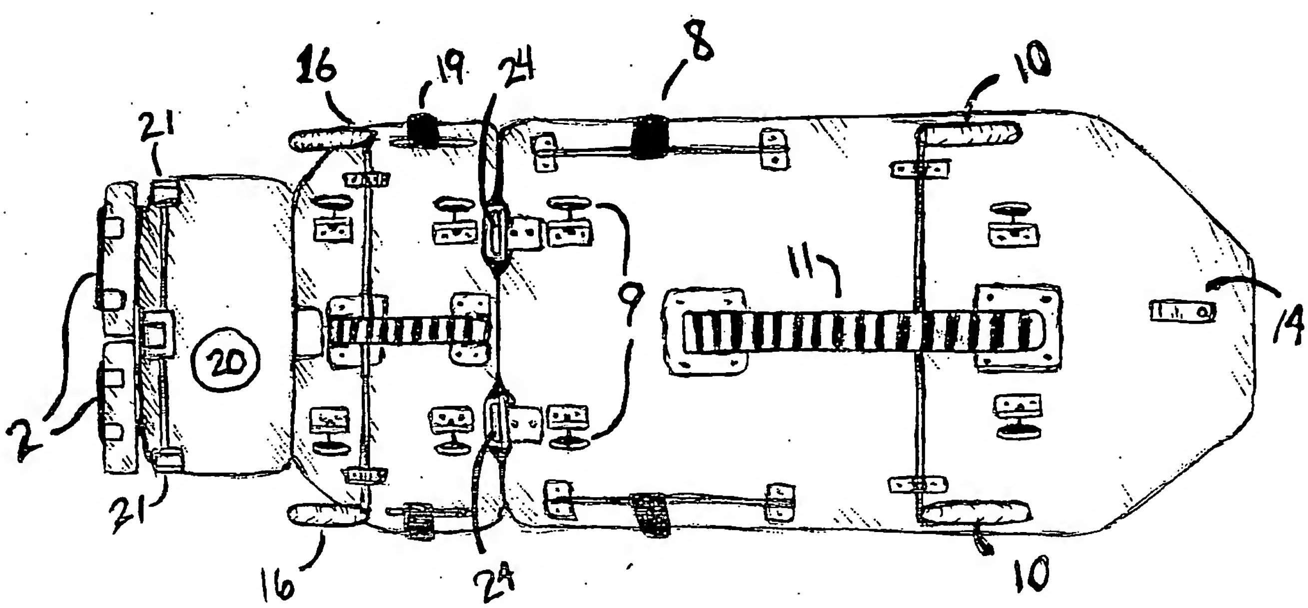
Figure 4. Side view of exclusive arm exercise use



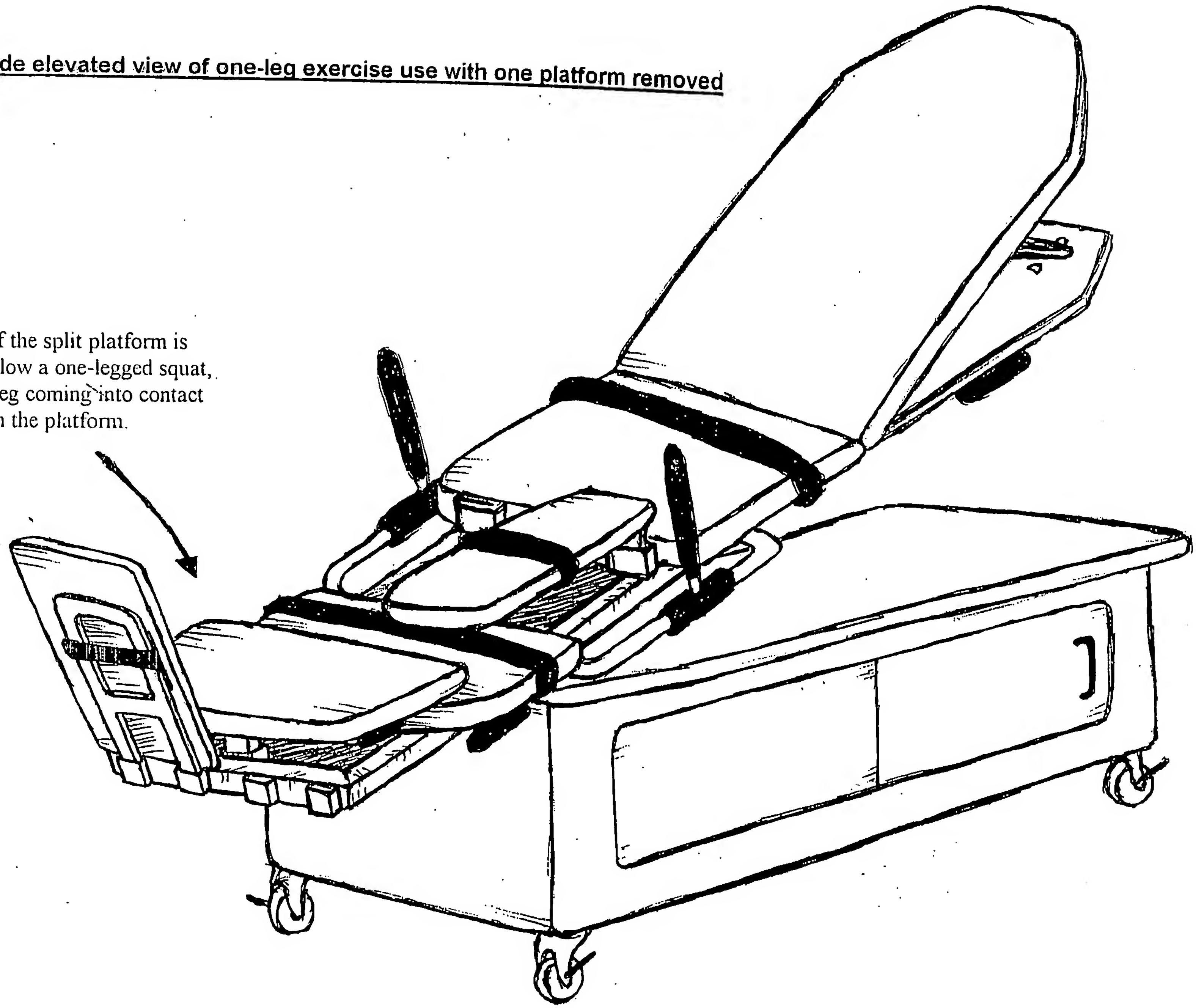
Top view of guide rails



Bottom View of carriage, center section, leg support, and split platform

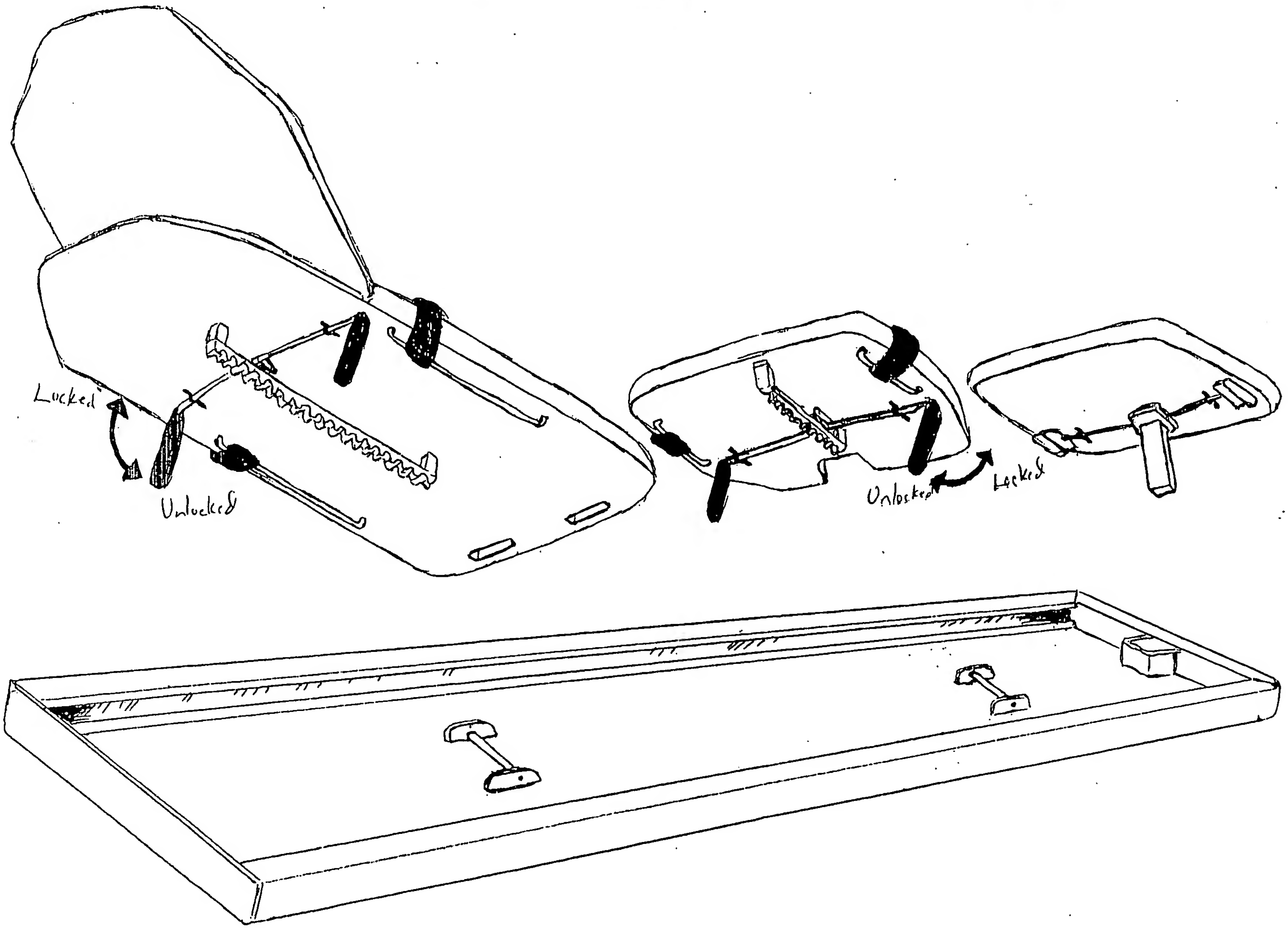


<u>Side elevated view of one-leg exercise use with one platform removed</u>



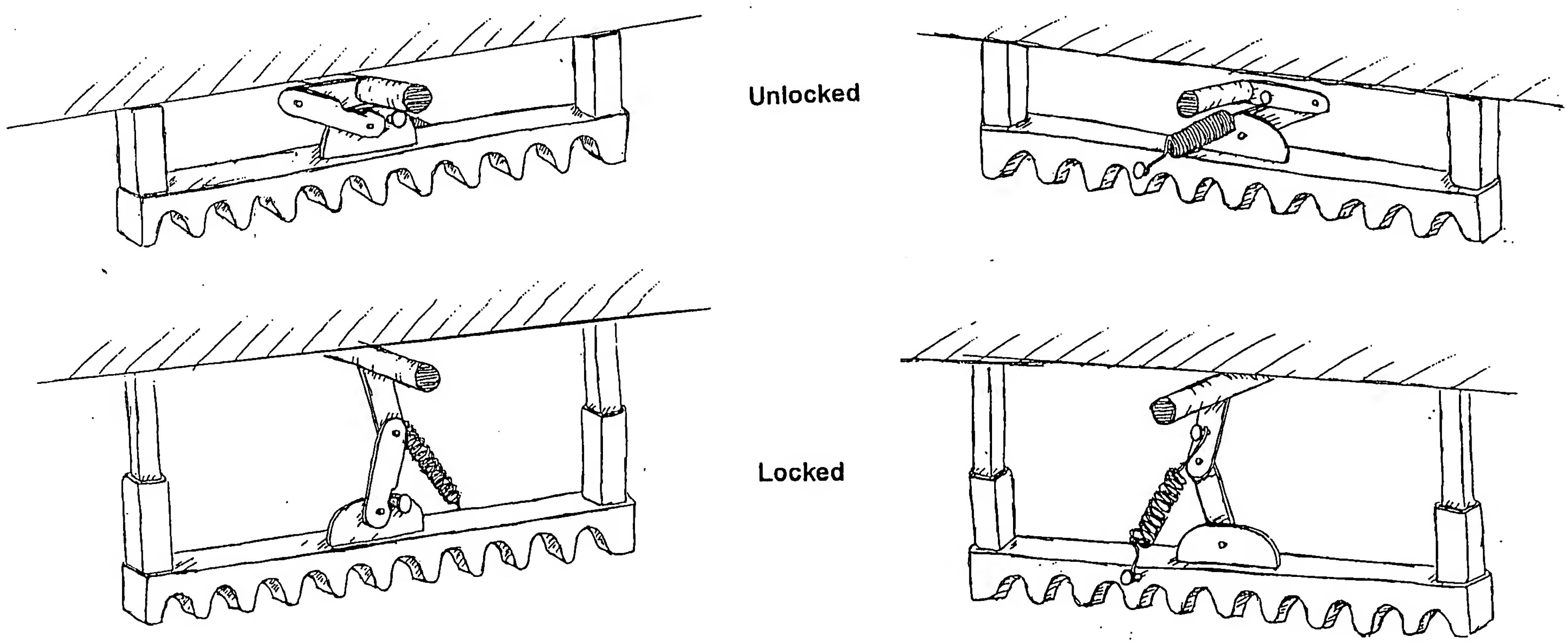
One side of the split platform is removed to allow a one-legged squat, without the leg coming into contact with the platform.

Side elevated view of guide rails, locking mechanisms, and safety straps

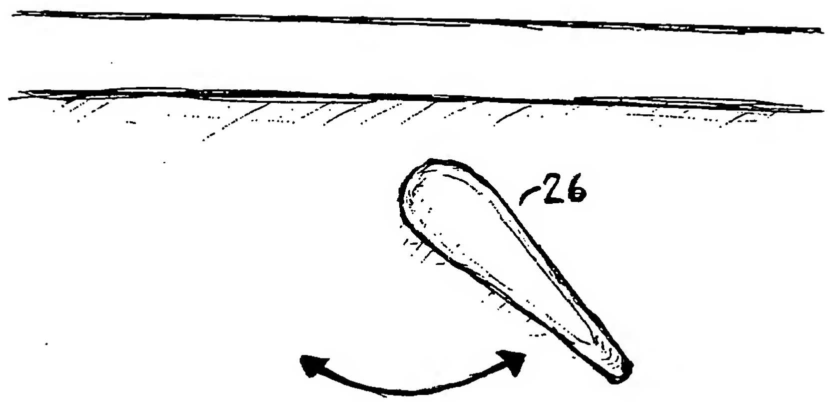


Side view of locking assembly

Left **Right**



Safety switch identifying table mode



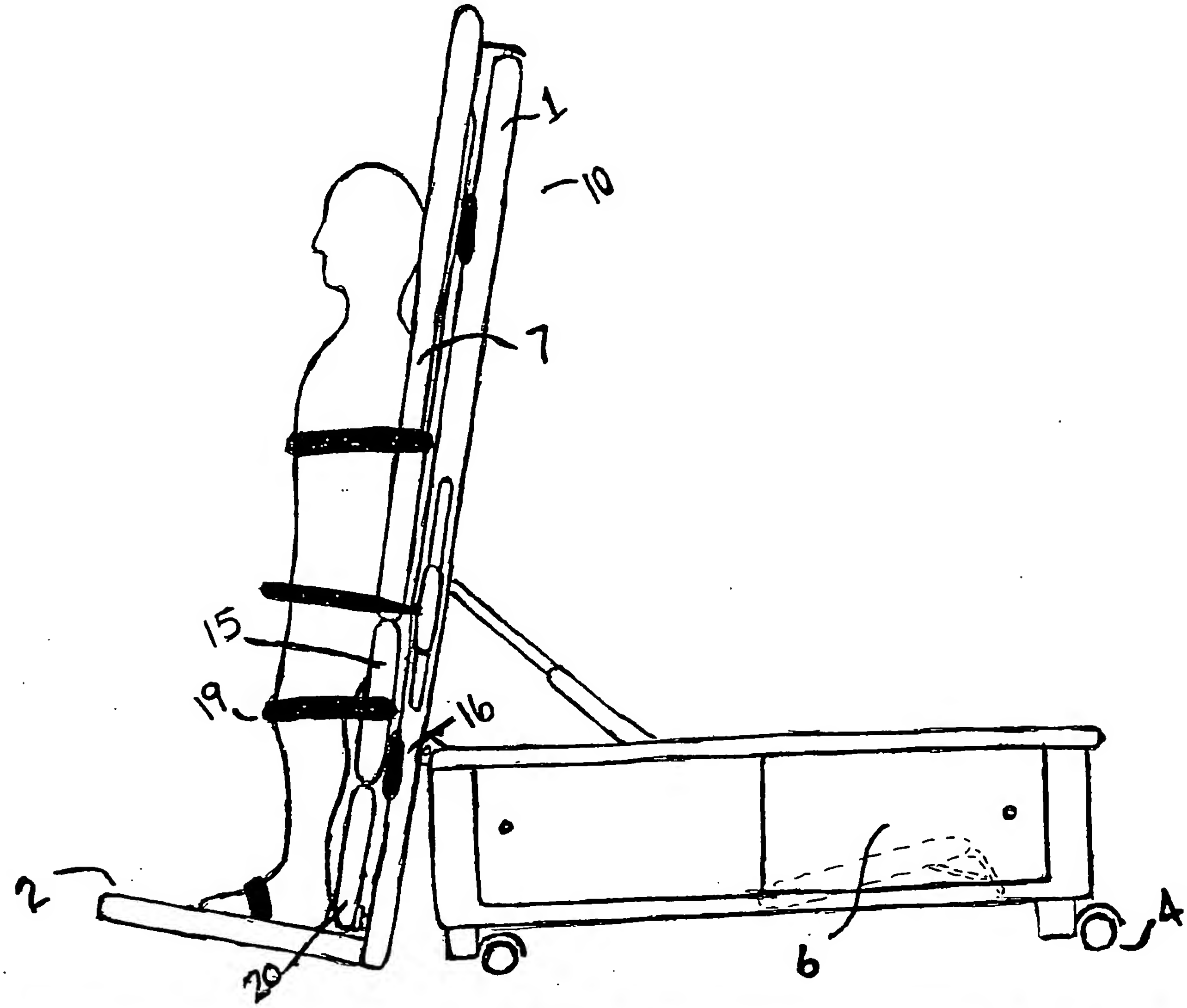
Tilt Table Mode

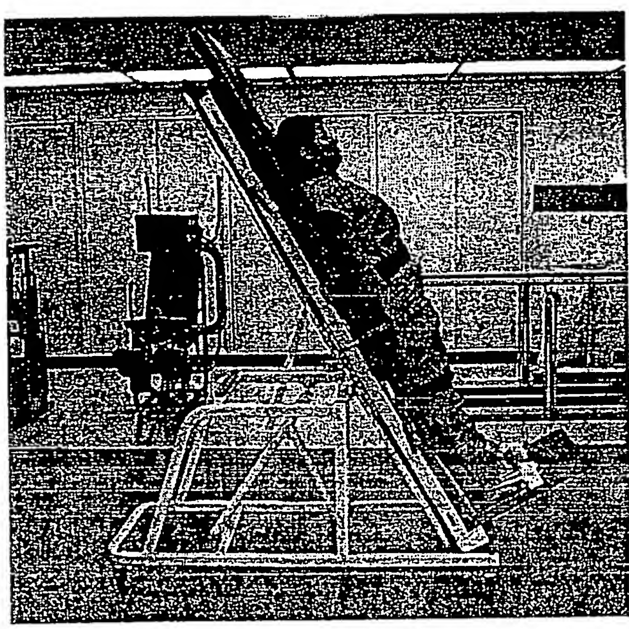
(0-85 degrees)

Exercise Mode

(0-35 degrees)

Figure 1. Side view of tilt table use





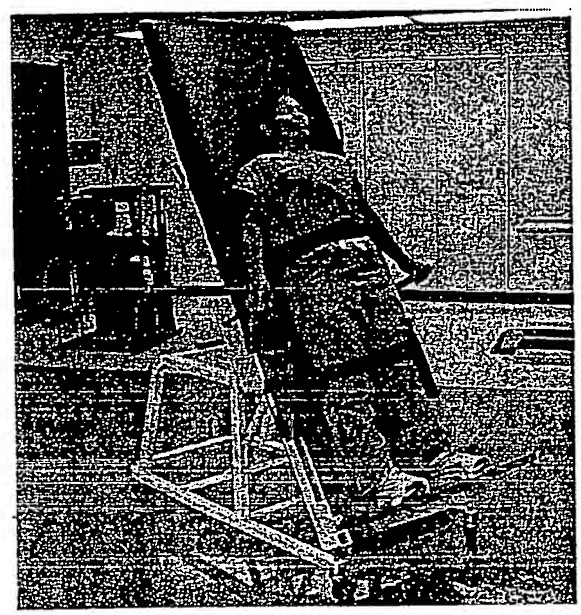
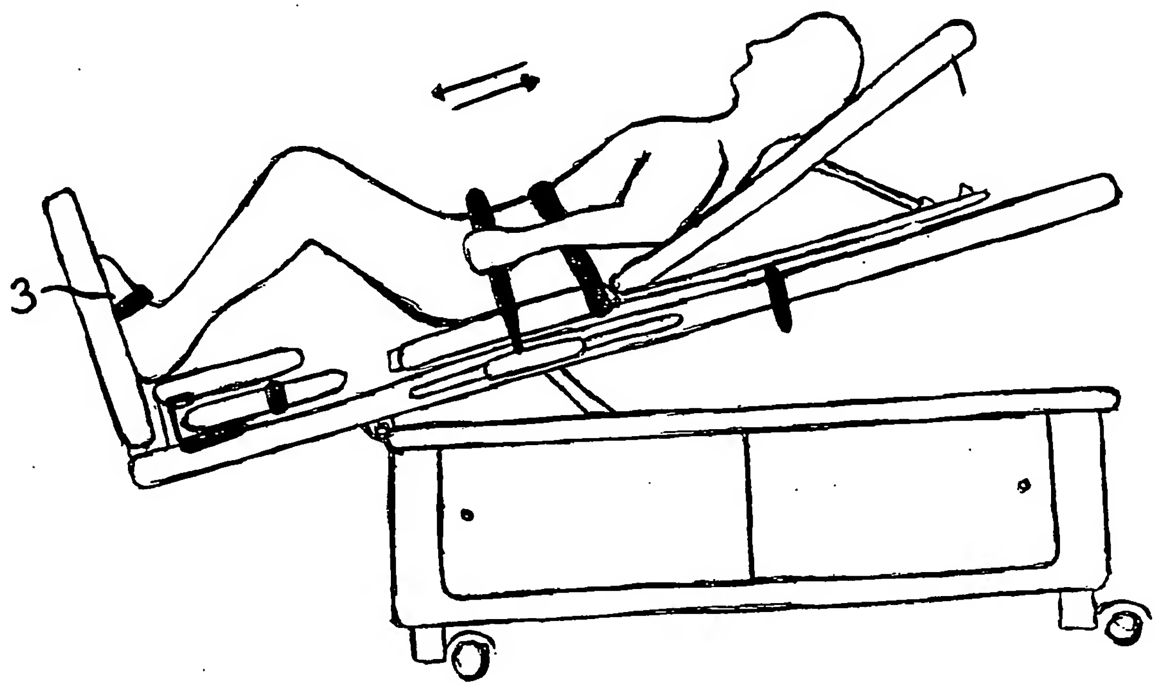
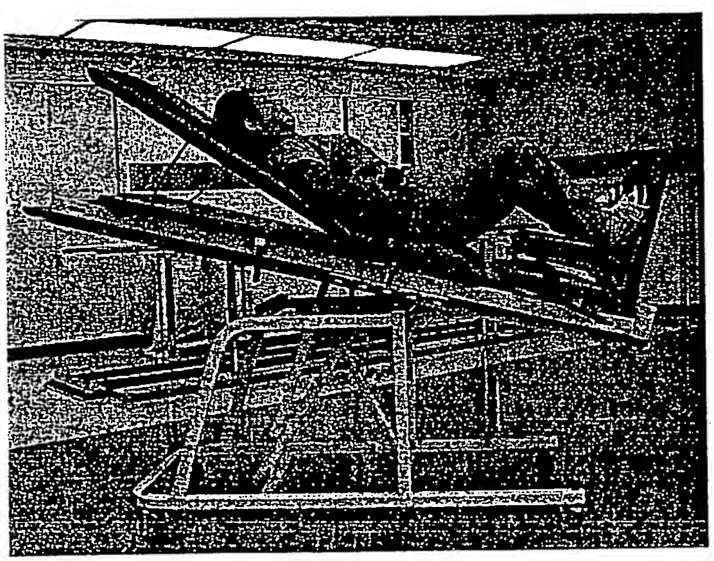


Figure 2. Side view of both leg exercise use





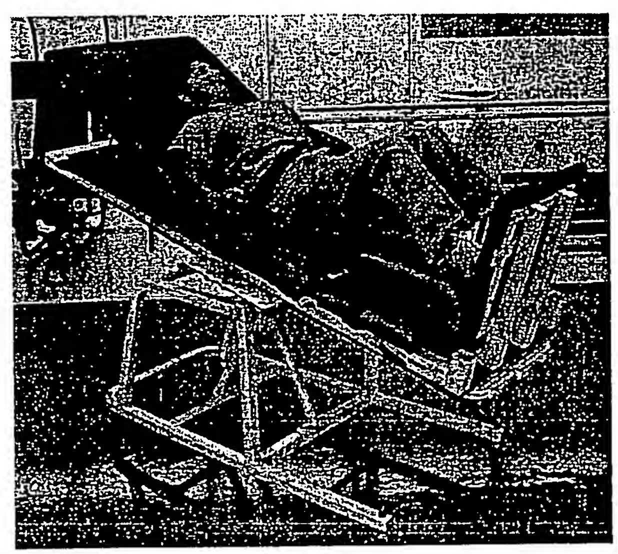
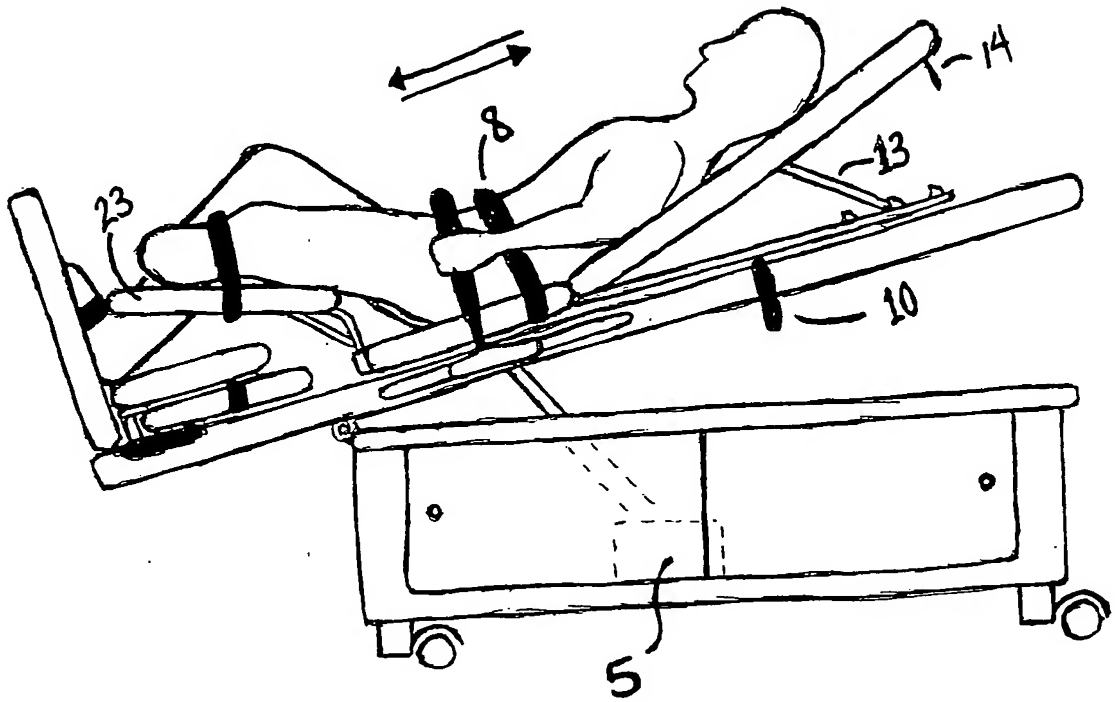


Figure 3. Side view of one leg exercise use



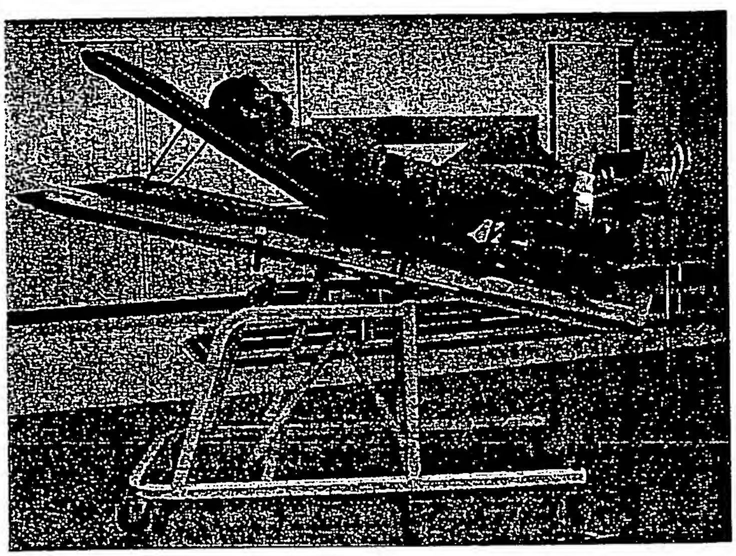
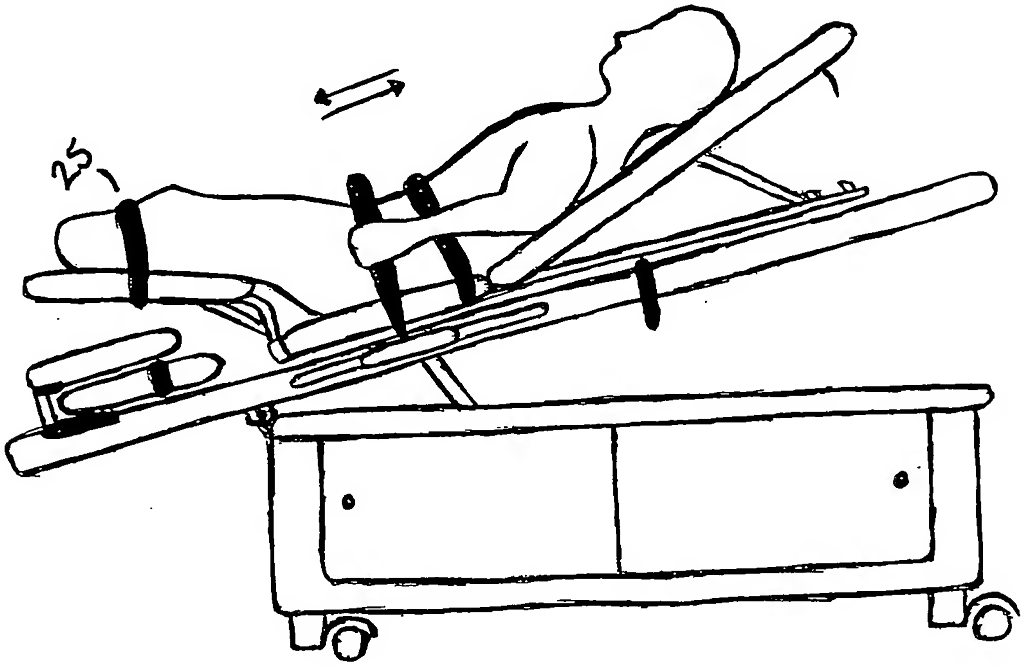
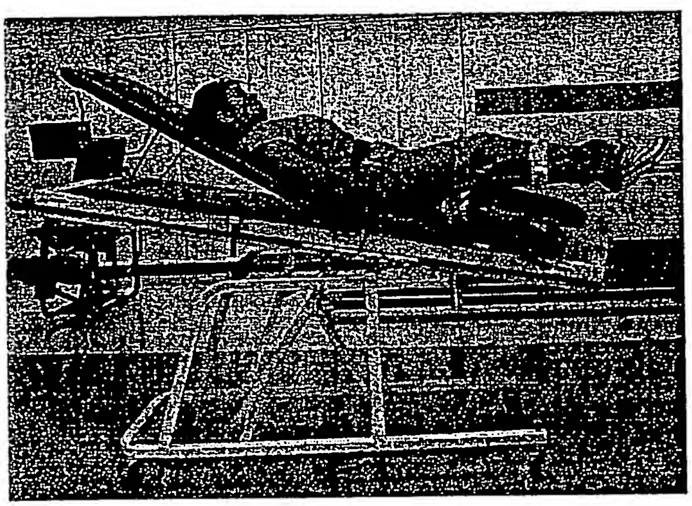
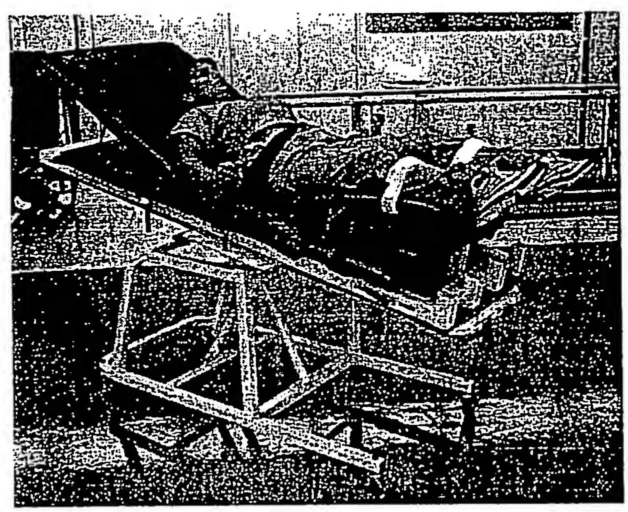


Figure 4. Side view of exclusive arm exercise use







What is claimed:

1. An apparatus comprising:

a first section having a first plurality of wheels affixed thereto;

a second section having an upper and lower surface and having a second plurality of wheels affixed to the lower surface;

a plurality of rails configured for receiving and guiding said first and second plurality of wheels, whereby the first and second sections are movable along the plurality of rails; and

a third section having an upper and lower surface, wherein the third section is movable in relation to the second section such that the lower surface of the third section is located in a plane parallel to and overlapping the plane of the upper surface of the second section.

2. An apparatus according to claim 1 further comprising a forth section located perpendicular to the upper surface of the third section.

3. An apparatus according to claim 2 further comprising safety straps.

4. An apparatus according to claim 2 further comprising a first locking mechanism to prevent the first section from being movable along the plurality of rails.

5. An apparatus according to claim 4 further comprising a second locking mechanism to prevent the second section from being movable along the plurality of rails.

6. An apparatus according to claim 2, wherein the forth section is comprised of two equal sections.

7. An apparatus according to claim 6, wherein one of the two sections is removed.

8. An apparatus according to claim 2, wherein the first section comprises a first portion and a second portion, wherein the second portion is movable in relation to the first portion.

9. An apparatus according to claim 8, wherein the second portion is hinged.

10. An apparatus according to claim 9, wherein the second portion can be located at an incline of between from 0 to 85 degrees in relation to the plane of the first portion.

11. An apparatus according to claim 10, wherein the second portion is fixed in place in relation to the first portion.

12. An apparatus according to claim 10, wherein the second portion further comprises a spring.

13. An apparatus according to claim 2 further comprising rotatable dip bars.

14. An apparatus according to claim 2 further comprising a fifth section removably connected to the first section.

15. An apparatus according to claim 10 further comprising an identification switch to indicate mode of operation.

16. An apparatus according to claim 15, wherein the identification switch limits the incline of the first portion to a maximum of 35 degrees.